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IS THE PRESENT ENTRANCE REQUIREMENT IN ALGEBRA EXCESSIVE IN AMOUNT? DOES IT EXPECT TOO GREAT MATURITY OF THE STUDENT?

By Elizabeth Forrest Johnson.

That the present algebra requirement has increased very markedly in actuality if not in the actual words in which it is described during the last fifteen years, I think is unquestionably true. From this increase, a very marked increase, an increase in difficulty of requirement, an increase in mathematical grasp expected of our students—from this increase I think there comes a very great temptation to the secondary schools to shave the requirement down to its lowest terms, to plan very closely, to economize at every point, to spare the students, to help the students out. And then in the last year when the students are finishing the requirement, we face the question, "Is it not perhaps altogether excessive? Doesn't it assume a maturity that our students have not?" My answer to that question sounds paradoxical when it is stated, and yet I very firmly believe it is true. My answer is something like this: If the algebra requirement of the colleges is interpreted grudgingly, if a school in planning its course holds itself down to the requirement reduced to lowest terms, the course will be narrow and barren, breathless, and of too great pressure; whereas, if the requirement is interpreted generously, if the course gives not merely what is required, but a good deal more than is required, then the course will prove to be not too taxing.

For consideration to-day, I wish to speak only of the requirement as defined by Bryn Mawr College, and as defined by the College Entrance Examination Board, because those two requirements taken together seem rather thoroughly to cover the field and because they are the requirements with which I am most familiar.

Those requirements both include elementary operations, fractions, factoring, radicals, exponents—integral, fractional, positive, negative—quadratics, problems, ratio and proportion, arithmetic and geometric progressions, the binominal theorem for positive integral exponents. The College Entrance Board requires, in addition, familiarity with the use of graphical methods and illustrations, and ability to solve problems chosen from mensuration, physical formulas, and the like. Bryn Mawr College does not require these, but does require ability to give rigorous mathematical proofs of certain pieces of algebraic theory—the remainder theorem, the factor theorem, for example—the proof of the binomial theorem, the proof that the quadratic equation has two and only two roots; proof connected with the theory of quadratics, proofs of the meaning of the fractional and negative exponents, the derivation of the formulas used in the progressions—twenty or more of such proofs, and all pretty difficult for the average student.

Any mathematician reading those requirements in the light of the papers set by Bryn Mawr College, and by the College Entrance Examination Board, will feel, I think, that, where they diverge, the Bryn Mawr requirement has the forward look to pure mathematics, and the College Board requirement has the forward look to applied mathematics. Now, my conviction, very steadily deepening from year to year, is that a mathematics course which simultaneously meets both these requirements is an almost ideal course, and that it is not too heavy nor expecting too great maturity if certain rather definite conditions can be established in the course. I sum up these conditions somewhat in this way:

In the first place, the mathematics course of the school must be planned as a whole, and from the first grade through the twelfth, by mathematicians.

In the second place, the course should include certain items, although, so far as I know, no college requirement specifically mentions them, or refers to them. In the lower grades, before the secondary school, the course should include geometric applications; for instance, actual measurements, some work in inductive geometry. The course should include the use of algebraic symbols, at least as early as the sixth grade. And there should be careful drill to train in speed and accuracy, such drill being based on some such devices as the Courtis tests. In the secondary school, the graph should be used to introduce simultaneous equations, not left until the very end of the course and dragged in as a long and cumbersome application to the simultaneous equation already familiar to the students. And somewhere in the secondary school there should be included a good course in inductive geometry.

In the third place, time enough should be given in the secondary school to do this mathematics course; that is, at least four years of work in the secondary school, not, I think, at all necessarily five times a week. Perhaps the ratio should be about two years and a half for algebra to a year and a half for geometry, but throughout the course there should be an abundance of geometric application to algebra, and of algebraic application to geometry.

In the fourth place, if the mathematics department consists of more than one teacher, at least one teacher should be a mathematician whose forward look is naturally to pure mathematics; and at least one whose forward look is naturally to applied mathematics.

A course planned thus generously along these lines will, I am sure, bring results that are well worth the time given it. Facility in handling the tools of mathematics, skill and power in abstract reasoning of a really difficult sort, developed by the theoretical work mentioned before; power to apply later these skills and methods to the natural sciences—that is what a school course preparing for these two requirements will give, if the schools will give the mathematicians a chance by allowing sufficient time for the work and by paying proper attention to its planning. If the mathematics course aims at less than this, it aims, it seems to me, at very much less. Either, it will aim merely at preparation for such requirement as the College Entrance Board requirement—a requirement utilitarian, scientific, sound, but from the point of view of the mathematician lacking the vision, the forward look towards higher, pure mathematics that those rigorous proofs demanded by Bryn Mawr College give our students, a glimpse that they enjoy even while they find them difficult; or, it will aim merely at meeting a requirement such as the Bryn Mawr requirement—beautiful mathematics, but without that connection with the natural sciences that, for so many young minds of the concrete type, makes all the difference between light and darkness. To accomplish either aim without the other is, paradoxically enough, to work too hard and attain too little; to do both is practicable, economical of time and energy.

Specifically, I should advocate omitting certain definite items from the requirement, not that to do so will save much time, but because I think mathematically they are out of place. I should omit the proof, not the applications, of the binomial theorem, for I think that proof is best given once for all in the college course in connection with permutations and combinations. I should omit, possibly, one or two other definite items of proof. But the omission or inclusion of these is to my mind really unimportant. The important matter is the generous scope of the planning of the mathematics course, and the planning of it as a mathematical unity from the first grade to the twelfth grade.

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